

REDUCTION OF INTRASPECIES AGGRESSION IN RATS BY POSITIVE REINFORCEMENT OF INCOMPATIBLE BEHAVIORS¹

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Fighting responses were elicited by response-independent shocks delivered to pairs of rats. Food pellets were presented following different non-fighting responses to shock: some pairs of rats received pellets dependent upon a specific non-fighting response to shock; others received pellets dependent upon any non-fighting response to shock; and control pairs never received pellets. The mean probability of an elicited aggressive response to shock was reduced to 0.2 by food reinforcement for a specific non-fighting response, and to 0.5 by food reinforcement for any kind of non-fighting response. These values contrasted with the 0.8 probability of elicited aggression when pairs of rats received no food reinforcement. Consistent findings were obtained when treatment conditions were changed for individual pairs of rats.

Recent findings indicate that elicited aggression is affected by operant contingencies; elicited aggression can be decreased by punishing the aggressive response. A series of experiments by Baenninger and others (*e.g.*, Myer and Baenninger, 1966) showed that mouse-killing by rats can be suppressed by punishment. Ulrich, Wolfe, and Dulaney (1969), and Baenninger and Grossman (1969) demonstrated, respectively, suppression of shock-elicited hose-biting in monkeys and of tail-pinch elicited fights in pairs of rats, both by response-dependent shock. Azrin (1970), with monkeys, and Roberts and Blase (1971), with rats, demonstrated that the degree of suppression is directly related to the intensity of the punishing shocks.

In only one experiment has an attempt been made to eliminate elicited aggression by reinforcing responses incompatible with fighting, rather than punishing the fighting response itself. This study (Ulrich and Craine, 1964)

used rats and attempted to eliminate fighting by negatively reinforcing any responses incompatible with fighting. However, the duration of fighting episodes increased under this procedure. These authors suggested that the specificity of the nonaggressive response chosen for reinforcement may be a critical factor in reducing the frequency of fighting in response to shock. The present experiment examined this possibility by varying that specificity. In addition, positive reinforcement was used.

METHOD

Subjects

Eighteen Holtzman Sprague-Dawley male rats, 73 days old at the start of experimentation, were maintained on a food regimen of 12 g of Purina Lab Chow per day with water always available in the home cage. All subjects were studied between 8:30 a.m. and 1:30 p.m. daily, and were fed at 4:00 p.m. Subjects were 70 days old when received from the Holtzman Co. and were individually housed upon arrival.

Apparatus

The Lehigh Valley Electronics experimental chamber (model number LVE 1417) measured 9 by 12 by 11 in. (24.1 by 30.5 by 26.7 cm). It had a grid floor and two metal walls wired to deliver shock from a Grason-Stadler E1064GS Shock Generator. The front and rear walls and ceiling were clear Plexiglas. One metal side wall of the chamber was modified such that

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²These findings were briefly noted as part of a paper presented at the 1971 Annual Conference of the New Zealand Psychological Society at the University of Canterbury at Christchurch, while the second author was a Visiting Professor at the University of Otago, Dunedin, New Zealand.

two food magazines projected into the chamber from adjacent corners. The left-hand (L) magazine was located 0.25 in. (0.3 cm) from the rear of the chamber; the right-hand (R) magazine was located 0.25 in. from the front of the chamber. The chamber was housed within a larger sound-attenuating box, and a ventilator fan provided masking noise. Relay equipment was in an adjoining room.

Procedure

Subjects were randomly paired and allocated to three groups of three pairs each. Each subject was trained to approach and eat 4.0 mm by 3.3 mm, 45-mg Noyes pellets from a food magazine in response to a 1.0-sec, 1400-Hz, 80-dB tone that signalled pellet delivery. One member of each pair of subjects was trained to approach the left magazine and the other member to approach the right magazine. Then, each subject had one 15-min magazine training session per day for six days. All subjects responded consistently to the tone and ate the pellet by Sessions 5 and 6. There were no systematic differences between groups in rate of acquisition. Training continued for four more sessions with the subjects now paired; during this phase, all subjects continued to respond appropriately to the tone and eat all the pellets presented.

Beginning in the eleventh session, each pair received during a 10-min session 120 unavoidable, 0.5-sec, 2-mA shocks with a fixed shock-shock interval of 4.5 sec. In addition, three different treatment conditions obtained.

For three pairs of rats in the Specific-response condition, food pellets were delivered if, while the 0.5-sec shock was on, the members of each pair went to different food magazine corners. This criterion was considered met if the nose of the rat was within about 2 in. (5 cm) of a magazine corner, and oriented such that it was pointing toward the corner or toward some point on a wall within about 2 in. of the corner. Neither subject was required to go to a specific magazine corner. If, immediately following shock onset, one subject went to or stayed in one of the magazine corners and the other subject went to or stayed in the other magazine corner, tone plus food pellets immediately followed shock termination for both rats.

For three pairs of rats in the Any-response condition, food pellets were delivered if, dur-

ing the time shock was on, the members of the pair emitted any behavior not classified as fighting. The final three pairs of rats in the Control condition received shock treatment identical with that of the first two groups, but never received food pellets.

For all rats, any stereotyped fighting posture (*cf.* Ulrich and Azrin, 1962), biting or striking movements on the part of either subject toward its partner was defined as a fighting response. For any one shock, only one fighting episode was counted. The first author observed and recorded these aggressive episodes and delivered food pellets according to group assignment. As a reliability check, the second author observed sessions periodically; agreement between observers on such occasions always exceeded 94%.

During Sessions 11 and 12, tone response and eating were disrupted by the shock. Therefore, it was decided to return the pairs of subjects to magazine-training for four sessions to reestablish a consistent magazine approach and eating response to tone presentation, and to make certain procedural changes. After retraining (Sessions 13 to 16), shock sessions recommenced with two modifications of the previous procedure. First, the shock-shock interval was increased to 9.5 sec, reducing the number of shocks per 10-min daily session to 60. Second, a pre-shock period averaging 5 min in duration was added. During this period wherein no fights ever occurred, approximately six tone-signalled pellets per minute were periodically delivered independently of the rats' behavior. All subjects ate under the new procedures.

Twenty six daily sessions under these new shock conditions (Sessions 17 to 42) constituted the first shock phase. During the second shock phase (Sessions 43 to 60), treatment conditions were changed for two of the three pairs previously trained on the Specific-response condition, and for two of the three pairs previously trained on the Control condition. In the former case, two pairs were switched from Specific-response to Control conditions, while in the latter, two pairs were switched from Control to Specific-response conditions. All other pairs received the same treatment during the second shock phase as during the first.

During the third shock phase (Sessions 61 to 69), the pair that had remained in the Specific-response condition throughout Phases 1 and 2

was switched to the Any-response condition. The pairs that had remained in the Any-response condition throughout Phases 1 and 2 were also switched: one pair received Control conditions during the third phase, and the other received Specific-response conditions. (The Any-response pair switched to Control conditions was composed of two Any-response rats paired during the second phase after their original partners died.)

RESULTS

The findings of the first shock phase are plotted in Figure 1 (Sessions 17 to 42). Differences in the probability of fighting in response to shock as a function of the different experimental treatments are clear. Each data point represents a group's mean fighting probability for that session. For each pair in a group, the probability of a fight in response to shock during the session was calculated by dividing the number of fights recorded during that session by 60, the number of shocks. These probabilities were then averaged for each group. Control pairs (C) developed higher fighting probabilities than either Any- (A) or Specific-response (S) pairs. Fighting probabilities increased over sessions for the Control group until they reached an asymptote at about 0.8. Rats in the Any-response group showed a rise in fighting probabilities over the first seven days (Sessions 17 to 23) and, with one exception (A3), fought less than Control pairs but more than Specific-response pairs, having fight-

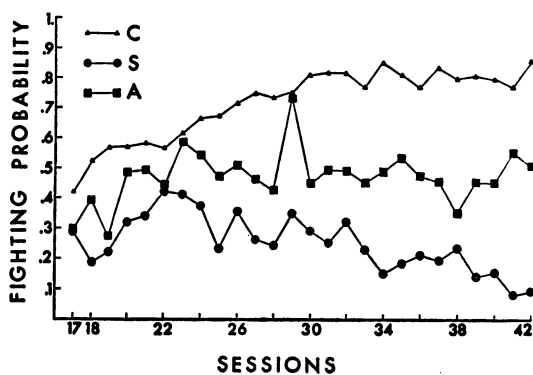


Fig. 1. Mean probability of elicited fighting in three groups of rat pairs for 26 days. C: Control group, no reinforcement. S: Specific-response group, a specific non-fighting response to shock reinforced. A: Any-response group, any non-fighting response to shock reinforced.

ing probabilities of approximately 0.5 by the end of the first shock phase. Finally, the fighting probabilities of Specific-response pairs increased over the first several sessions, but then decreased with continued training from a high of 0.4 to a low of 0.1.

Figure 2 is a plot of the individual-pair data, rather than group means, showing individual variability through the last five sessions of the first shock phase, and through all of the second and third shock phases.

The top (A.) frame of Figure 2 shows the effects of switching the three pairs of rats in the Control group to each of the other conditions. Two Control pairs were switched to the Specific-response condition in Session 43, and a decrease in fighting probabilities to about 0.2 resulted. The third Control pair (C3) was switched to the Any-response conditions in Session 61. Before this switch, the pair fought with about 0.8 probability, but afterward fighting decreased to the level shown by pairs initially under the Any-response condition.

The middle (B.) frame of Figure 2 shows the effects of switching the three pairs of rats in the Specific-response group to each of the other treatment conditions. Two Specific-response pairs were switched to Control conditions in Session 43, and showed an increase in fighting probability to 0.7-0.8 during the last days of the experiment. The third Specific-response pair (S3) was switched to Any-response conditions in Session 61, but no change in fighting probability occurred. The pair had developed lower fighting probabilities in Sessions 43 through 60, while still under Specific-response conditions, than they had previously had in Sessions 17 through 42. Since the pair had been emitting virtually no non-fighting response other than the one previously reinforced, the change in contingencies could not, of course, be expected to have an effect on its performance.

Finally, the bottom (C.) frame of Figure 2 shows the behavior of the two surviving Any-response pairs after both were switched in Session 61. One pair, switched to Control conditions, fought more than it had previously, with fighting probabilities reaching the typical 0.8 level. The other pair, switched to Specific-response conditions, continued to fight with a probability of about 0.6. The fact that one subject of the pair ate inconsistently, with behavior not effectively reinforced sufficiently

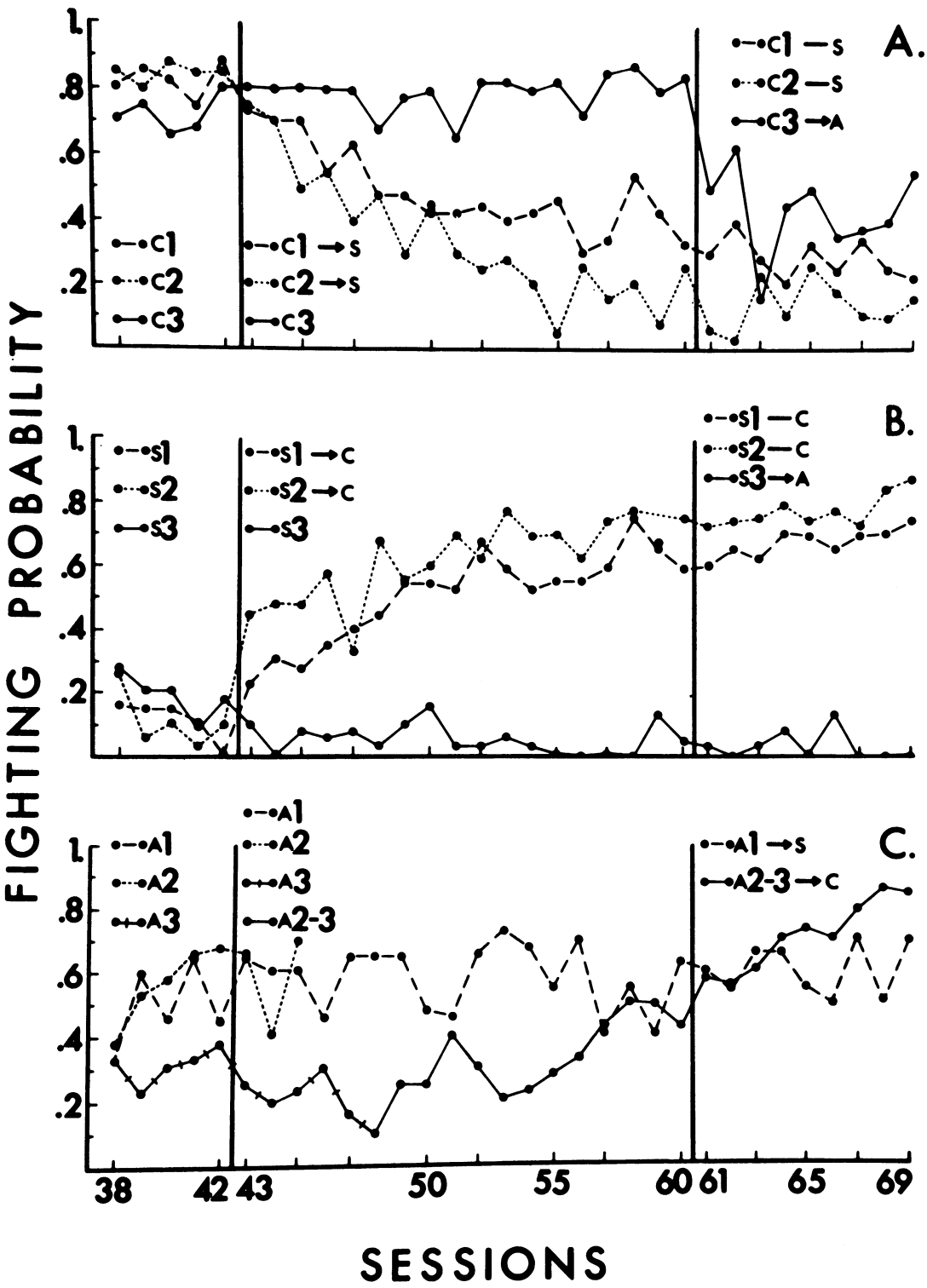


Fig. 2. Probability of elicited fighting in individual pairs of rats for 32 sessions with various reinforcement schedules. Arrow indicates change in treatment of a pair starting the day after the indicated vertical division (e.g., S1 → C indicates pair S1 was changed from Specific-response to Control conditions).

often, may account for the failure of this particular change in contingencies to produce an expected decrease in fighting. No other subject ate inconsistently. Visual observation indicated that for Specific-response pairs, nonaggressive responding did not dominate until each subject consistently went to a specific magazine corner. Before such specific behavior appeared, subjects would frequently both go to the same magazine corner, or switch corners during shock.

The behavior that replaced fighting in Specific-response pairs was the same in all such pairs. Typically, during a series of non-fighting responses to shock, subjects scrambled in their respective magazine corners (where they remained between shocks), moved their feet rapidly, sometimes jumped in the corner during shock, and ate immediately afterwards. In addition, it was specifically noted that the least aggressive pair (see S3, Figure 2B) developed a stereotyped behavior pattern during the second and third shock phases. Besides showing the behaviors just noted, this pair regularly oriented toward each other after eating and, with shock onset, turned away from each other toward the corners.

DISCUSSION

The present results are consistent with Ulrich and Craine's (1964) suggestion that the specificity of the nonaggressive response chosen for reinforcement is a critical factor in reducing the frequency of fighting in response to shock. In the present experiment, pairs of rats whose specific non-fighting responses to shock were reinforced, fought substantially less than rats for which any non-fighting response was reinforced, and these rats, in turn, fought less than rats whose non-fighting responses were not reinforced at all. Further, reinforcing a specific non-fighting response might well have been more effective if the response had been even more specific. Under the conditions that obtained, a subject could receive pellets either for going to the right-magazine corner or for going to the left-magazine corner, so long as its fellow subject chose the other corner on that occasion. Given these conditions, responding was not efficient until each subject developed the even more specific response of going to a given magazine corner. Presumably, conditioning would have proceeded more rapidly if rein-

forcement had been made dependent on that more specific response. The importance of response specificity is thus indicated not only by the difference in the behavior of Any- and Specific-response pairs, but also by the correlation for Specific-response pairs between the development of more specific responding and a decrease in fighting probability.

An alternative formulation of these findings is possible, namely that the effects seen may merely have been due to the separation of the rats and orientation away from each other produced by the presentation of reinforcement in adjacent corners of the chamber. In other words, if the rats in the Specific-response condition ran to different corners, they were separating themselves from each other more than members of pairs in the Any-response condition, thus lowering fighting probability (e.g., Ulrich and Azrin, 1962). A corollary to this is the possibility that at a shock-shock interval of 9.5 sec, animals tend to remain in the fighting posture between shocks and, therefore, animals that had not just received food would be more likely to fight than subjects whose responses had been reinforced on the previous trial.

Two observations run contrary to these suggestions, however. The first is that, as previously noted, the members of the least aggressive pair regularly oriented toward each other between shocks, yet did not fight in response to shock. The second is that Any-response pairs frequently checked the food magazines even after fighting, so that there was no noticeable difference in the degree of separation produced in Any-response *versus* Specific-response pairs by the food magazines.

A question may also arise regarding the Any-response pair (A3) mentioned earlier which, in spite of the reinforcement procedure, developed a fighting probability almost as low as those of Specific-response pairs. This pair's behavior is consistent with the demonstrated importance of specificity. The pair emitted few non-fighting responses other than the specific one, namely the corner response, which was reinforced for Specific-response pairs, and thus had what were, in effect, Specific-response contingencies. The emission of a limited variety of non-fighting responses may have been the result of the pair's initial high tendency to approach the food magazines. Other Any-response pairs had a lower frequency of corner responses. Magazine approach was thus rein-

forced for this pair from the start and its frequency as a non-fighting response to shock was higher for this pair than for the other Any-response pairs.

Thus, positive reinforcement of either a specific non-fighting behavior or any non-fighting behavior was found effective in decreasing elicited fighting, with the former being more effective than the latter. That reinforcement of any non-fighting response was effective is a finding in contrast to that of Ulrich and Craine (1964), who reported an increase in fighting with continued training. The most obvious difference between the two studies apart from response specificity may be responsible for these contrasted findings. The present experiment used positive reinforcement whereas Ulrich and Craine used negative, turning continual shock off for 60 sec if pairs of rats stopped fighting. In the latter case, continuing the shock (whose removal constituted reinforcement) tended to elicit the very behavior that was to be eliminated.

The present findings seem important within the context of what Skinner (1966) called the differences between phylogenic and ontogenic contingencies in the provenance of behavior. Such experimentation may provide a way of elucidating differences. More importantly, it shows that elicited aggressive behavior can be controlled by accessible variables whatever its provenance (*cf.* Skinner, 1969, pp. 199-206 and 212). Punishment studies have found that elicited fighting can be clearly suppressed by manipulating its consequences directly (*e.g.*, Azrin, 1970; Roberts and Blase, 1971), and the present experiment has shown that aggressive behavior can be markedly reduced by reinforcing non-fighting behavior that occurs when the eliciting stimulus occasionally fails to produce the aggressive behavior. In short, behavior that is usually presumed part of the subject's inherited repertoire (*i.e.*, has a phylogenic prov-

enance) is easily brought under the control of contingencies operating in the ontogeny of the individual.

While it is clear that some behaviors with a phylogenic provenance can be modified by ontogenic contingencies, the degree to which this may be possible for a given behavior in a given species is not clear. The speculation might be risked that knowledge of the degree to which or ease with which a response of phylogenic provenance can be modified would be useful in understanding the role of that response in the survival of that species.

REFERENCES

- Azrin, N. H. Punishment of elicited aggression. *Journal of the Experimental Analysis of Behavior*, 1970, **14**, 7-10.
- Baenninger, R. and Grossman, J. C. Some effects of punishment on pain-elicited aggression. *Journal of the Experimental Analysis of Behavior*, 1969, **12**, 1017-1022.
- Myer, J. S. and Baenninger, R. Some effects of punishment and stress on mouse killing by rats. *Journal of Comparative and Physiological Psychology*, 1966, **62**, 292-297.
- Roberts, C. L. and Blase, K. Elicitation and punishment of intraspecies aggression by the same stimulus. *Journal of the Experimental Analysis of Behavior*, 1971, **15**, 193-196.
- Skinner, B. F. The phylogeny and ontogeny of behavior. *Science*, 1966, **153**, 1205-1213.
- Skinner, B. F. *Contingencies of reinforcement: a theoretical analysis*. New York: Appleton-Century-Crofts, 1969.
- Ulrich, R. E. and Azrin, N. H. Reflexive fighting in response to aversive stimulation. *Journal of the Experimental Analysis of Behavior*, 1962, **5**, 511-520.
- Ulrich, R. E. and Craine, W. H. Behavior: persistence of shock-induced aggression. *Science*, 1964, **143**, 971-973.
- Ulrich, R. E., Wolfe, M., and Dulaney, S. Punishment of shock-induced aggression. *Journal of the Experimental Analysis of Behavior*, 1969, **12**, 1009-1015.

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